

Claims

1. A method of controlling the pitch of a controllable pitch marine propeller of a watercraft, comprising the
5 steps of:

providing a cruise mode in which engine speed and pitch of the propeller are adjusted to enable the speed of advance of the watercraft to be varied, and wherein the engine speed is adjustable up to a maximum engine speed;

10 providing a manoeuvring mode in which the pitch of the marine propeller is adjusted whilst maintaining engine speed within a predetermined limit less than the maximum engine speed;

providing an engine check mode in which the engine
15 can be revved without drive being supplied to the propeller; and

providing a pitch check mode in which the pitch of the propeller can be adjusted without rotating the
propeller.

20 2. The method of claim 1 wherein the method includes providing one or more selectors to select the manoeuvring mode, the cruise mode, the engine check mode or the pitch check mode, and a drive actuator for movement between
25 extreme positions so that in the manoeuvring mode, movement of the drive actuator changes the pitch of the propeller whilst limiting engine speed, and in cruise mode, movement of the drive actuator changes engine speed and pitch of the propeller.

30 3. The method of claim 1 wherein the step of providing the manoeuvring mode maintains engine speed substantially constant at a speed equal to or less than the said predetermined limit.

35 4. The method of claim 1 wherein the step of providing the manoeuvring mode comprises adjusting the engine speed whilst also adjusting the pitch of the propeller.

5. The method of claim 1 wherein the predetermined limit is about 30% of maximum engine speed.

5 6. The method of claim 1 wherein the method includes providing a transition mode routine so that, should the mode be changed between manoeuvring mode and cruise mode, a smooth transition occurs to prevent unwanted response from the watercraft due to the position of the drive
10 actuator at the time of change between the manoeuvring mode and the cruise mode.

7. The method of claim 1 wherein the method further includes providing sub routines when in the cruise mode,
15 to determine wide open throttle condition required by a watercraft operator, normal cruise condition in which engine speed or watercraft speed is adjusted in accordance with the position of the drive actuator to achieve best fuel efficiency, and power stop condition in which the
20 pitch of the propeller is adjusted into a full reverse position with engine power available throughout the transition from forward movement of the watercraft to a stopped condition of the watercraft or until the watercraft is controlled to again advance.

25 8. The method of claim 7 wherein the method comprises maintaining the power stop condition for a predetermined time period, or until the watercraft is controlled to again advance.

30 9. The method of claim 1 wherein the method includes, when in the power stop routine, monitoring watercraft speed.

35 10. The method of claim 9 wherein the speed may be presented by way of a look-up table so that for particular pitch amounts and propeller speeds, an appropriate speed value is provided.

11. The method of claim 10 wherein the watercraft speed values are approximated from the equation:

5 $\text{speed} = \text{pitch amount} \times \text{propeller rotation speed} - \text{slip}.$

12. A system for controlling the pitch of a controllable pitch marine propeller of a watercraft, comprising:

a controller for:

- 10 (a) providing a cruise mode in which engine power and pitch of the propeller are adjusted to enable the watercraft to cruise, and wherein the engine speed is adjustable up to a maximum engine speed;
- 15 (b) providing a manoeuvring mode in which the pitch of the marine propeller is adjusted whilst maintaining engine speed within a predetermined limit less than the maximum engine speed;
- 20 (c) providing an engine check mode in which the engine can be revved without drive being supplied to the propeller; and
- 25 (d) providing a pitch check mode in which the pitch of the propeller can be adjusted without rotating the propeller.

25 13. The system of claim 12 wherein the system includes providing one or more selectors for selecting the manoeuvring mode, the cruise mode, the engine check mode or the pitch check mode, and a drive actuator for movement between extreme positions so that in the manoeuvring mode, movement of the drive actuator changes the pitch of the propeller whilst maintaining engine speed substantially constant, and in cruise mode, movement of the drive actuator changes engine speed and pitch of the propeller.

35 14. The system of claim 12 or 13 wherein the controller is also for providing a transition mode routine so that, should the mode be changed between manoeuvring mode and cruise mode, a smooth transition occurs to prevent

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unwanted response from the boat due to the position of the drive actuator at the time of change between the manoeuvring mode and the cruise mode.

5 15. The system of claim 12 wherein the controller is also for providing sub routines when in the cruise mode to determine wide open throttle condition required by a watercraft operator, normal cruise condition in which watercraft speed is adjusted in accordance with the
10 position of the control lever, and power stop condition in which the pitch of the propeller is adjusted into a full reverse position with engine power available throughout the transition from forward movement of the watercraft to a stopped condition of the watercraft or until the
15 watercraft is controlled to again advance.

16. The system of claim 15 wherein the controller maintains the power stop condition for a predetermined time period, or until a watercraft is controlled to again
20 advance.

17. The system of claim 12 wherein the system includes a speed sensor for monitoring watercraft speed when in the power stop routine, and the controller maintains power
25 stop until a predetermined speed is reached.

18. The system of claim 17 wherein the controller maintains power stop until a predetermined speed is reached, and the speed is presented by way of a look-up
30 table so that for particular pitch amounts and propeller rotation speeds, an appropriate speed value is provided.

19. The system of claim 18 wherein the watercraft speed is approximated from the equation:

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$$\text{speed} = \text{pitch amount} \times \text{propeller rotation speed} - \text{slip}$$

20. A system for controlling the pitch of a controllable

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pitch marine propeller of a watercraft having an engine, comprising:

a drive actuator for manual movement by a watercraft operator of the watercraft;

5 a controller for controlling engine power and pitch of the marine propeller;

a mode selector for selecting a cruise mode or a manoeuvring mode for the watercraft; and

10 wherein the controller is also for receiving control signals from the mode selector and from the drive actuator, and when the mode selector is actuated to place the watercraft in the manoeuvring mode, the controller limits engine rpm speed to within a predetermined value less than maximum engine speed and controls the pitch of
15 the propeller blades in accordance with the manual movement of the drive actuator by the watercraft operator to change watercraft speed, and when the mode selector is in the cruise mode, the controller sets engine power up to the maximum engine speed and propeller pitch in accordance
20 with movement of the drive actuator by the watercraft operator to change watercraft speed.

21. The system of claim 20 wherein the controller when in the manoeuvring mode maintains engine speed substantially
25 constant at a speed equal to or less than the said predetermined limit.

22. The system of claim 20 wherein the controller when in the manoeuvring mode adjusts the engine speed whilst also
30 adjusting the pitch of the propeller.

23. The system of claim 20 wherein the predetermined limit is about 30% of maximum engine speed.

35 24. The system of claim 20 wherein the controller comprises a pitch control unit which controls engine power by selecting an output for supply to the engine from a look up table dependent upon the manually adjusted

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position of the drive actuator, and a pitch motor controller for receiving outputs from the pitch control unit to adjust the pitch of the propeller.

5 25. The system of claim 20 the system includes a pitch control motor for adjusting the pitch of the propeller and the pitch motor controller is for supplying an output
10 signal to the pitch control motor to actuate the pitch control motor to adjust the propeller to the desired pitch.

26. The system of claim 21 wherein the system includes a sensor for providing a measure of the pitch of the
15 propeller blades, the sensor being coupled to the pitch control unit so the pitch control unit is provided with a signal indicative of the pitch of the propeller.

27. The system of claim 20 wherein the watercraft includes a clutch for selectively disconnecting power from
20 the engine to the propeller or enabling power to be supplied from the engine to the propeller, a clutch actuator connected to the clutch and the pitch control unit being for supplying a control signal to the actuator to open or close the clutch.

25 28. The system of claim 27 wherein the system includes a clutch position monitoring sensor for providing a signal indicative of whether the clutch is in the open or closed position, the sensor being connected to the pitch control
30 unit.

29. The system of claim 25 wherein the engine includes an rpm sensor for sensing engine speed, the rpm sensor being
35 connected to the pitch control unit.

30. The system of claim 29 wherein a speed measuring device is provided and connected to the pitch control unit for supplying a signal indicative of the speed of the

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watercraft to the pitch control unit.

31. The system of claim 20 wherein the controller determines watercraft speed from a look-up table so that
5 for particular pitch amounts and propeller rotation speeds, an appropriate speed value is provided.

32. The system of claim 31 wherein the watercraft speed is approximated from the equation:
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$$\text{speed} = \text{pitch amount} \times \text{propeller rotation speed} - \text{slip}.$$

33. The system of claim 30 wherein the speed measuring device is a GPS speed measuring system.

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34. The system of claim 20 wherein the mode selector comprises at least one switch for selectively placing the watercraft into the manoeuvring mode or the cruise mode.

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35. The system of claim 34 wherein a second switch is provided for placing the watercraft into a pitch check mode or an engine check mode.

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36. The system of claim 35 wherein the switches are momentary contact switches to place the system in the cruise mode or manoeuvring mode, and the pitch check mode or engine check mode by causing modes to toggle between the cruise mode and manoeuvring mode, and pitch check mode and engine mode.

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37. The system of claim 20 wherein the system includes a clutch engage actuator for actuation by the watercraft operator so the pitch control unit can be overridden if attempting to open the clutch to maintain the clutch in a
35 closed position so power is delivered from the engine to the propeller.

38. The system of claim 20 wherein the system includes a

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propeller stop element for actuation by the watercraft operator to perform an emergency stop of the propeller, the propeller stop element being connected to the pitch control unit so that upon actuation of the propeller stop
5 element, the pitch control unit reduces engine speed and opens the clutch to shut off rotary power from the engine to the propeller, and adjust the position of the propeller to neutral position.

10 39. The system of claim 21 wherein the pitch control unit, when the pitch check-engine check mode switch is actuated, causes the clutch to open so that drive is not supplied from the engine to the propeller and in the engine check mode position, the pitch control unit outputs
15 a signal to the engine to cause the engine to rev in accordance with the position of the drive actuator, as controlled by the watercraft operator, and when in the pitch check mode position, causes a signal to be output to the pitch motor controller and then to the pitch motor to
20 adjust the pitch of the propeller dependent on the movement of the drive actuator.

40. The system of claim 39 wherein the pitch control unit includes a look up table of values for output to the pitch
25 motor controller dependent upon the position of the drive actuator so that an appropriate value is selected for supply to the pitch motor controller to in turn control the pitch motor to adjust the pitch of a propeller to a position dependent on the position of the drive actuator.

30 41. The system of claim 20 wherein the drive actuator is a control lever moveable between a full forward position to a full reverse position.

35 42. A method of controlling the pitch of a controllable pitch marine propeller of a watercraft which has an engine, comprising the steps of:

providing a cruise mode in which engine power and

propeller pitch position is adjusted by manual operation of a drive actuator so the engine power is increased or decreased to drive the watercraft by rotation of the propeller and adjusting of the pitch of the propeller to achieve a required watercraft speed, the engine speed being adjustable up to a maximum engine speed;

providing a manoeuvring mode in which engine speed is limited to less than the maximum engine speed and propeller pitch is adjusted by manual control of a drive actuator by the watercraft operator to enable the boat to be manoeuvred by pitch control of the propeller which varies the speed of the watercraft; and

providing a transition mode so that when the mode is changed from the cruise mode to the manoeuvring mode, or from the manoeuvring mode to the cruise mode, engine speed and propeller pitch are not changed in an undesirable fashion upon change between the modes if the location of the manually controlled drive actuator is in such a position which would otherwise cause the watercraft to respond in an undesirable manner.

43. The method of claim 42 wherein a single drive actuator is provided for changing watercraft speed when in the cruise mode, and changing propeller pitch when in the manoeuvring mode.

44. The method of claim 42 wherein the transition mode determines whether the drive actuator position is beyond a predetermined limit and sets a predetermined engine speed and adjusts the pitch of the propeller dependent upon watercraft speed.

45. The method of claim 42 wherein the transmission mode still further comprises preventing the watercraft from operating in manoeuvring mode and in such time as the drive actuator is manually adjusted by the watercraft operator to a position which matches engine speed and pitch of the propeller and thereafter continued movement

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of the drive actuator enables the watercraft operator to drive the watercraft in cruise mode by movement of the drive actuator.

5 46. The method of claim 42 wherein the step of providing the manoeuvring mode maintains engine speed substantially constant at a speed equal to or less than the said predetermined limit.

10 47. The method of claim 42 wherein the step of providing the manoeuvring mode comprises adjusting the engine speed whilst also adjusting the pitch of the propeller.

15 48. The method of claim 42 wherein the predetermined limit is about 30% of maximum engine speed.

49. A system for controlling the pitch of a controllable pitch marine propeller of a watercraft which has an engine, comprising:

20 a controller for:

(a) providing a cruise mode in which engine power and propeller pitch is adjusted by manual operation of a drive actuator so the engine power is increased or decreased between maximum and minimum engine speeds to drive the watercraft by rotation of the propeller and adjusting of the pitch of the propeller to achieve a required watercraft speed;

25 (b) providing a manoeuvring mode in which engine speed is limited to a limited speed less than the maximum engine speed and propeller pitch is adjusted by manual control of a drive element by the watercraft operator to enable the boat to be manoeuvred by pitch control of the propeller which varies the speed of the watercraft; and

30 (c) providing a transition mode so that when the mode is changed from the cruise mode to the manoeuvring mode, or from the manoeuvring mode to the cruise mode, engine speed and propeller pitch are not

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changed in an undesirable fashion upon change between the modes if the location of the manually controlled drive actuator is in such a position upon change of the mode so that the boat does not respond in an undesirable manner.

50. The system of claim 49 wherein the controller when in the manoeuvring mode maintains engine speed substantially constant at a speed equal to or less than the said predetermined limit.

51. The system of claim 49 wherein the controller when in the manoeuvring mode comprises adjusting the engine speed whilst also adjusting the pitch of the propeller.

52. The system of claim 49 wherein the predetermined limit is about 30% of maximum engine speed.

53. The system of claim 49 wherein a single drive actuator is provided for changing engine speed when in the cruise mode, and changing propeller pitch when in the manoeuvring mode.

54. The system of claim 49 wherein the transition mode determines whether the drive actuator position is beyond a predetermined limit and sets a predetermined engine speed and adjusts the pitch of the propeller dependent upon watercraft speed.

55. The system of claim 49 wherein the controller is also for, when in the transition mode, preventing the watercraft from operating in cruise mode until such time as the watercraft operator moves the drive actuator to a position which matches the engine speed and pitch of the propeller.

56. The system of claim 49 wherein the controller is also for monitoring watercraft speed and setting engine power

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as a function of the engine speed whilst controlling the pitch of the propeller to maintain that watercraft speed when transitioning from manoeuvring mode to cruise mode.

- 5 57. The system of claim 54 wherein the controller is also for monitoring watercraft speed and setting engine speed to a predetermined speed and propeller pitch to a pitch dependent on watercraft speed when transitioning from cruise mode to manoeuvring mode.

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58. A method for controlling the pitch of a controllable pitch marine propeller of a watercraft which has an engine, comprising the steps of:

- 15 providing a power stop mode for rapidly reducing speed of the watercraft when the watercraft is advancing; and

- 20 adjusting the pitch of the propeller into a full reverse position with engine power being available throughout the transition from advancing movement of the watercraft to a reduced forward speed of the watercraft.

- 25 59. The method of claim 58 wherein the method includes maintaining continuous engine power available until the watercraft stops or until the watercraft is controlled by a watercraft operator.

- 30 60. The method of claim 58 wherein the method includes determining a power stop requirement by monitoring the speed of movement of a drive actuator to place the propeller in a full reverse pitch position.

- 35 61. The method of claim 58 wherein the method includes monitoring watercraft speed and maintaining the watercraft in power stop mode until the watercraft reaches a predetermined speed or is controlled by an operator by movement of an actuating device to operate the boat other than in power stop mode.

62. The method of claim 58 wherein the method comprises maintaining the power stop condition for a predetermined time period, or until a watercraft is controlled to again advance.

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63. The method of claim 58 wherein the step of providing the manoeuvring mode maintains engine speed substantially constant at a speed equal to or less than the said predetermined limit.

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64. The method of claim 58 wherein the step of providing the manoeuvring mode comprises adjusting the engine speed whilst also adjusting the pitch of the propeller.

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65. The method of claim 58 wherein the predetermined limit is about 30% of maximum engine speed.

66. A system for controlling the pitch of a controllable pitch marine propeller of a watercraft which includes an engine, comprising:

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a drive actuator moveable from a forward position to a reverse position;

a controller for adjusting the pitch of the propeller to place the pitch in a fully reverse position; and

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wherein the controller is for determining the requirement for power stop by monitoring movement of the actuator and for, upon determination of power stop, adjusting the pitch of the propeller to the full reverse position with engine power available throughout the transition from forward movement of the watercraft to a reduced speed of the watercraft.

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67. The system of claim 66 wherein the controller is for maintaining continuous engine power until the watercraft stops or the actuator is moved by the watercraft operator.

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68. The system of claim 66 wherein the controller is for determining the requirement for power stop by monitoring

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the speed of movement of the actuator to the full reverse position.

69. The system of claim 66 wherein the drive actuator
5 comprises a control lever.

70. The system of claim 66 wherein the system includes a speed sensor for providing a signal indicative of speed of the watercraft and the controller is for maintaining the
10 watercraft in power stop mode until a predetermined watercraft speed is reached or the drive actuator is actuated by an operator to operate the watercraft in other than power stop mode.

71. The system of claim 70 wherein the power stop mode is maintained until the watercraft reaches a predetermined speed, and the watercraft speed is presented by way of a look-up table so that for particular pitch amounts and propeller rotation speeds, an appropriate speed value is
20 provided.

72. The system of claim 71 wherein the watercraft speed is approximated from the equation:

25 $\text{speed} = \text{pitch amount} \times \text{propeller rotation speed} - \text{slip}.$

73. A method of controlling the pitch of a controllable pitch marine propeller of a watercraft which includes an engine, comprising:

30 providing an indication of the speed of the watercraft;

using the speed of the watercraft to control engine power dependent on any one or more of the parameters selected from the following group of parameters: propeller
35 pitch, and operating mode of the water craft.

74. The method of claim 73 wherein the operating mode is a set cruise control mode in which it is desired to

maintain the watercraft speed at a constant speed and wherein engine power is adjusted to maintain that constant speed.

5 75. The method of claim 73 wherein the operating mode includes a power stop mode in which watercraft speed is used to determine when watercraft speed drops to a predetermined minimum speed so that power stop mode continues, unless otherwise overridden by operator
10 control, until the minimum watercraft speed is produced.

76. The method of claim 75 wherein the engine speed also is used to set the power of the engine at the commencement of power stop so that a particular engine power is
15 selected dependent on the speed of the watercraft.

77. The method of claim 73 wherein the operating mode includes transition modes which are implemented when the operating mode of the watercraft is changed between a
20 cruise mode and a manoeuvring mode, and wherein the engine power is selected dependent on the boat speed during transition between the cruise mode and the manoeuvring mode to produce a smooth transition between the cruise mode and manoeuvring mode.

25 78. The method of claim 73 wherein the watercraft speed is used to produce the smooth transition when transitioning from both the cruise mode to the manoeuvring mode and from the manoeuvring mode to the cruise mode.

30 79. The method of claim 78 wherein the watercraft speed is presented by way of a look-up table so that for particular pitch amounts and propeller rotation speeds, an appropriate speed value is provided.

35 80. The method of claim 79 wherein the watercraft speed is approximated from the equation:

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speed = pitch amount x propeller rotation speed - slip.

81. A system for controlling the pitch of a controllable pitch marine propeller of a watercraft which includes an engine, comprising:

a speed means for providing an output indicative of the speed of the watercraft; and

a controller for using the output to control engine power dependent on any one or more of the parameters selected from the following group of parameters: propeller pitch, and operating mode of the water craft.

82. The system of claim 81 wherein the operating mode is a set cruise control mode in which the controller maintains the watercraft speed at a constant speed and wherein engine power is adjusted to maintain that constant speed.

83. The system of claim 81 wherein the operating mode includes a power stop mode in which the output is used to determine when watercraft speed drops to a predetermined minimum speed so that power stop mode continues, unless otherwise overridden by operator control, until the minimum watercraft speed is produced.

84. The system of claim 81 wherein the system comprises maintaining the power stop condition for a predetermined time period, or until a watercraft is controlled to again advance.

85. The system of claim 83 wherein the engine speed also is used to set the power of the engine at the commencement of power stop so that a particular engine power is selected dependent on the output indicative of speed of the watercraft.

86. The system of claim 81 wherein the operating mode includes transition modes which are implemented when the

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operating mode of the watercraft is changed between a cruise mode and a manoeuvring mode, and wherein the engine power is selected dependent on the output during transition between the cruise mode and the manoeuvring mode to produce a smooth transition between the cruise mode and manoeuvring mode.

87. The system of claim 86 wherein the output is used by the controller to produce the smooth transition when transitioning from both the cruise mode to the manoeuvring mode and from the manoeuvring mode to the cruise mode.